REPORT RESUMES

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HIGH SCHOOL PHYSICS BY TELEVISION--THE HOUSTON AREA PROJECT.
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THE EFFECTIVENESS OF TELEVISION TEACHING WAS INVESTIGATED UNDER VARIED CONDITIONS OF SCHOOL ORGANIZATION SUCH AS URBAN-RURAL, SEGREGATED SCHOOLS, AND HOMOGENEOUS GROUPING. ADDITIONAL OBJECTIVES OF THE PROJECT WERE TO (1) INTRODUCE TEACHING BY OPEN-CIRCUIT TELEVISION AMONG INDEPENDENT SCHOOL DISTRICTS IN THE HOUSTON AREA, (2) DEVELOP PRACTICAL WORKING RELATIONSHIPS BETWEEN THE TELEVISION STATION OF THE UNIVERSITY OF HOUSTON (KUHT) AND THE PUBLIC SCHOOL SYSTEMS, (3) INVESTIGATE TEAM TEACHING AND IMPROVEMENT OF TEAM TEACHING, AND (4) IMPROVE THE QUALITY OF INSTRUCTION OF HIGH SCHOOL PHYSICS. THE SUBJECT OF HIGH SCHOOL PHYSICS WAS CHOSEN BECAUSE OF ITS POTENTIAL FOR DEMONSTRATION TEACHING AND BECAUSE OF CURRICULUM NEEDS. THE TEST RESULTS INDICATED THAT TELEVISION-TAUGHT HIGH SCHOOL CLASSES ACHIEVED EQUALLY AS WELL AS THE TRADITIONALLY TAUGHT CONTROL CLASSES. THERE WAS ALSO EVIDENCE THAT HOMOGENEOUS CLASSES WERE MORE EFFECTIVE THAN HETEROGENEOUS CLASSES WITH TELEVISION TEACHING. IN ADDITION, THE RURAL HIGH SCHOOL CLASSES AND THE NEGRO HIGH SCHOOL CLASSES MADE SATISFACTORY GAINS WITH TELEVISION TEACHING. INCLUDED IN THE REPORT WERE DISCUSSIONS OF THE ADMINISTRATION OF TELEVISED INSTRUCTION IN RELATION TO INDEPENDENT SCHOOL DISTRICTS, AND THE ROLE OF THE TEAM TEACHER AND HIS CLASSROOM TECHNIQUE. (GD)

HIGH SCHOOL PHYSICS BY TELEVISION: THE HOUSTON AREA PROJECT

Prepared Under Provisions of a Research Grant
U. S. Office of Education
Department of Health, Education, and Welfare

Wallace H. Strevell

September 1960

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A PUBLICATION OF THE
BUREAU OF EDUCATION RESEARCH AND SERVICES

UNIVERSITY OF HOUSTON

3801 CULLEN BOULEVARD
HOUSTON 4, TEXAS

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Credit for the original conception and development of the research project is due Dr. Lester S. Richardson, former Director of the Bureau of Education Research and Services. Dr. Richardson organized the administrative aspects of the project during the summer months and supervised the telecasting program during the fall term of 1959. The author of this report was appointed project director in February 1960 and completed during the spring and summer terms the gathering and analysis of research data.

An advisory committee of Harris County school superintendents was named to coordinate the program, including Dr. Floyd H. Burton, Chairman, Dr. H. M. Landrum, T. S. Hancock, and Dr. John W. McFarland; and a special committee on evaluation was appointed later consisting of Dr. Eugene Tenney, Chairman, Orris G. Bailey and Raymond Free.

The task of publishing lesson materials and maintaining contact with the high school physics teachers in the independent schools was assigned to John A. Outterson, the television instructor. A committee of physics teachers and supervisors, John A. Outterson, Chairman, John Pickens, Ken N. Locke, John Farmer, Dr. Eugene Tenney, Harmon Watts, Tom G. Parris, Allen M. Sory, and Jim Hademenos, were responsible for the lesson guide. Statistical analysis of research data was the duty of William J. Phalen, who had as technical advisor Dr. Daniel E. Sheer, Professor of Psychology, University of Houston.

Numerous individuals became interested and contributed unselfishly of their time: the guest scientists and resource persons on television, the department of physics of the University, the management of station KUHT, the Central Scientific Co. which supplied laboratory equipment, and the physics teachers who willingly participated and served on advisory committees.

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September 1960

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Nature of Experiment and Its Findings

An introductory project in the teaching of a high school subject directly by open-circuit television to classes located in independent school districts under varied conditions was cooperatively arranged and conducted by the University of Houston, College of Education, during school year 1959-60.

The basic lessons of a course in modern high school physics were telecast three days a week over the University of Houston educational television station KUHT. Research funds, under provisions of the National Defense Education Act, provided means whereby the Bureau of Education Research and Services, College of Education, was enabled to investigate "the effectiveness of teaching high school physics by television as determined by certain varied conditions."

The purposes of this project were as follows:

1. **To introduce teaching by open-circuit television among independent school districts in the Houston area.**
2. **To develop practical relationships, involving administration policy and practices, between the University of Houston television station KUHT and the public school systems and programs.**
3. **To conduct research on the effectiveness of television teaching under certain varied conditions of school organization such as urban-rural, segregated schools, and homogeneous grouping.**
4. **To investigate the characteristics of team teaching and the improvement of team teaching technique.**
5. **To raise the standards and quality of instruction in high school physics by effective use of educational television.**

This first chapter contains the statistical report of research as defined in Purpose No. 3. Subsequent chapters take up other purposes of the project.

REGIONAL SETTING OF THE EXPERIMENT

University of Houston television station KUHT, Channel 8, is located on the university campus near the geographic center of the industrial and metropolitan region of Houston, Texas. The terrain of the Gulf Coast region is level, so that viewing conditions are fairly uniform within range of the station's signal. KUHT is a VHF station noted as being among the pioneer full-time educational television stations of the nation. It has frequently served as an open-circuit television station for specific purposes within the Houston Public Schools, besides its adult education and other functions.

Some concept of the Houston project area is gained when one considers that Harris County alone in 1959-60 enrolled over 210,000 students in its twenty independent school districts. The Harris County School Administrators proposed in the spring of 1959 the cooperative planning of an introductory program in the teaching of a high school subject by open-circuit television to regular classes in the several school districts. The subject of high school physics was chosen because of its timely need from the curriculum standpoint and its potentials for demonstration teaching. It was realized that the total number of children enrolled in this particular subject would be limited, scheduling adaptations would be quite intricate, and classes would often be small in size.

Necessary preliminary arrangements were completed, a research grant was obtained, and regular telecast lessons were started on September 30. 1959. When the program of telecasts terminated on May 16, 1960, complete test data and information had been gathered on twenty-two high school physics classes which had viewed the telecast lessons. Of these viewing classes, fifteen classes had watched all the telecast lessons and had followed completely the outline instructions. There were seven viewing classes which had watched the telecast lessons a part of the year and engaged in related work.

THE CRITERION MEASUREMENT

The varied conditions, under which effectiveness of teaching high school physics by open-circuit television was to be measured, were implicit in the legal and traditional structure of the independent school districts. In the project proposal, as originated by the Harris County School Administrators and representatives from other counties, and confirmed in a series of planning sessions with public school physics teachers, it had been stated that basic lessons of high school physics were to be taught by the television instructor one hour (40 to 50 minutes) a day for three days a week for the entire school year. Since the typical high school physics classes in the region meet for five periods a week of instruction including laboratory work, the regular high school physics teachers in charge of classrooms, acting as team teachers with the television instructor, would then have available two days a week for class laboratory work, necessary individual and group teaching, and student evaluation.

The issue as to whether telecasts should be in the nature of a basic course of instruction in physics or used only as resource enrichment was therefore decided, by conditions of the research proposal, in favor of a common course of study presented in the most complete, fully-equipped, accurately prepared, and up-to-date manner possible on television. The television instructor was an experienced high school physics teacher provided full-time by the Houston Public Schools for this purpose. He was supplied with the newest laboratory equipment. Technicians were assigned to direct the production. The course of study was entitled Modern Physics and a complete lesson plan guide of the telecast course of study was furnished all participants.

It was understood in the research proposal that mass-viewing situations would not be attempted, but rather the project would deal with typical high school physics classes located in assorted independent school districts, some in large urban high schools and others in comparatively small high schools having smaller size physics classes. The participating classes would occur in accordance with normal methods of scheduling classes. Classes viewing the telecast lessons would be termed experimental classes. Other physics classes not scheduled to watch the telecasts would be control classes.

The effectiveness of the program, which included the common telecast course of study, the cooperative lesson planning, and the work of the team teachers was for research purposes judged by a standardized high school physics examination, the Dunning Physics Achievement Test (World Book Company). At mid-term the Outterson Mid-Term Physics Test (Bureau of Education Research and Services) was given. In order that these tests could be interpreted in terms of individual pupil background and ability, the pupils early in the year were given the Iowa Physics Aptitude Examination, Form M, and the Otis Gamma Quick-Scoring Mental Ability Test. All these tests were administered uniformly to more than one thousand high school physics students in experimental and control classes alike.

VARIABLES TO BE TESTED

In the research proposal it was stated as the purpose of the investigation to determine the effectiveness of teaching high school physics by television under certain varied conditions. Specific observations were to be made with respect to the following conditions:

A. Comparison of television-taught heterogeneously grouped classes with television-taught homogeneously grouped classes.
B. Comparison of television-taught heterogeneously and homogeneously grouped classes with matched heterogeneously and

homogeneously grouped classes taught by conventional methods.

C. Comparison of television-taught heterogeneously and homogeneously grouped city high school classes with television-taught heterogeneously and homogeneously grouped rural high school physics classes.

D. Comparison of television-taught heterogeneously and homogeneously grouped city and rural high school physics classes with matched heterogeneously and homogeneously grouped city and rural high school classes taught by conventional methods.

E. Under the same conditions, observations were to be made with respect to the performance of segregated white and Negro classes. (No integrated schools being within telecasting range of KUHT.)

This line of reasoning aroused many questions as to the effectiveness of television teaching compared with conventional teaching in relation to the training and experience of the classroom teacher, the gifted compared with slower pupils, the attitudes of teacher and pupil, the general calibre of the school including its science laboratory facilities, and particularly, the effect of the technique used by the team teacher.

Judgment and practical experience were gained through participation in the project with respect to: (1) involvement of participating teachers in preparing course outlines; (2) keeping team teachers informed about forthcoming programs and related or auxiliary activities, assignments, textbook study, discussion, and testing; (3) deciding which units of subject-matter content could be presented most effectively by television; (4) use of guest scientists and engineers, or of special field trips and equipment, on television; and (5) deciding the most effective division of time between the work of the television instructor and of the team teacher. In so far as light was shed on such related questions as these by measurements and statistical analysis, or by opinions and observations, they are treated in the chapters which follow.

In order to test the major hypotheses of the study as to the effectiveness under certain varied conditions, the experimental viewing classes included sixteen classes for white students, and six classes for Negro students; twelve city classes and ten rural classes. There were, in addition, thirty-one control classes similar in character to the experimental classes, and complete measurements and information were gathered on these.

Altogether twenty-nine independent school districts cooperated in the total project. Fifteen of these school districts had one or more classes viewing the physics telecasts. Sixteen high school physics teachers served as team teachers in classes viewing the telecasts and twenty-two physics teachers had non-viewing control classes. More than fifty teachers were on the actual mailing list for the course of study outlines since the list included teachers of several control classes that did not at the end take all the tests.

TABLE I. Participating School Districts, High Schools and Physics Classes by Size of School District Enrollment

Average Daily Attendance of School District 1959-1960	Number of School Districts	Number of High Schools	Number of Physics Classes	
			Experimental	Control
Less than 1,000	7	8	4	4
1,000-1,999	12	13	5	8
2,000-2,999	4	4	2	3
3,000-3,999				
4,000-4,999	1	2	1	2
5,000-5,999				
6,000-6,999				
7,000-7,999	1	1		1
8,000-8,999	2	2	2	2
9,000-9,999	1	2	2	2
More than 10,000	1	7	6	9
Total	29	39	22	31

Note: Includes seven part-time viewing classes.

CHARACTERISTICS OF THE SCHOOLS

As noted in Table I, there were thirty-nine high schools which took part in the project and submitted complete measurements. Of these, there were thirteen high schools having full-time experimental classes (plus five other high schools having classes viewing part-time or a part of the year, the data for which are not treated or included in the computations of Chapter I).

Seven Houston city high schools participating in the study and three high schools in suburban districts had multiple classes in physics; but the other twenty-nine high schools had only a single class in physics. The thirty-one control classes were distributed among twenty-four high schools.

TABLE II. Number of Classes and Pupils for Each Variable by Experimental and Control Groups

Variable		Experimental Group	Control Group
Homogeneous:	Classes	7	4
	Pupils	96	96
Heterogeneous:	Classes	8	27
	Pupils	90	140
Urban:	Classes	8	22
	Pupils	124	146
Rural:	Classes	7	9
	Pupils	62	90
White:	Classes	9	26
	Pupils	117	145
Negro:	Classes	6	5
	Pupils	69	91

Note: The part-time viewing classes are excluded in this table and in remaining computations of Chapter I.

Homogeneous and Heterogeneous Classes. At first it was thought that the ability grouping practices of several high schools might be compared and tested for effectiveness under television teaching. Observation of data, however, showed that the several high schools claiming to have ability grouping actually had more heterogeneity in their physics classes than others; and often they had less homogeneity than existed in many non-ability-grouped classes. Therefore an arbitrary standard was decided upon.

For purposes of research the rule was applied that to be denoted homogeneous the standard deviation of a class must be significantly less than the standard deviation of the total group in **both** the Otis Mental Ability Test scores and the Iowa Physics Aptitude Test scores.[1]

This strict rule produced eleven homogeneous classes and thirty-five heterogeneous classes. Of the eleven homogeneous classes, seven were full-time experimental classes and four were control classes.

The number of classes and pupils for each variable of the study is given in Table II.

Urban and Rural. Judged by economics and residential commuters, most of the viewing area of television station KUHT is substantially related to metropolitan Houston or to the industrial complex of the Houston-Galveston shipping channel. Therefore one would expect to find few rural schools in the sense of isolated rural communities. Nevertheless due to extensive ranching country and scattered residential living, many school districts of the area transport a large proportion of their high school pupils. These districts often have more the characteristics of rural living than suburban development.

From a knowledge of the districts, it was decided that those with less than fifteen pupils per square mile should be considered rural. The city of Houston has forty-six pupils per square mile. Thus of twenty-nine school districts in the study, sixteen were classed as rural and thirteen as urban. In terms of participating high schools, twenty-five were rural and fourteen urban. This division yielded nine rural classes and twenty-two urban classes among the thirty-one control groups; and it gave seven rural classes and eight urban classes among the fifteen full-time experimental groups.

Schools for White and Negro Students. At the time of the project, only segregated white and Negro high schools existed in the telecasting area. Participating in the project were thirty-two all white high schools and seven all Negro high schools. This yielded twenty-six for white students and five for Negro students as con-

1. Formula: $\sigma_\sigma = \frac{\sigma_t}{\sqrt{2N_c}}$ and $\frac{\sigma_t - \sigma_c}{\sigma_\sigma} \geq 1.645$

where σ_σ = the estimated standard deviation of a distribution of standard deviations for various sizes of N;

σ_t = standard deviation of the total population on either test;

N_c = number of students in any given class;

σ_c = standard deviation of any given class.

W.J.P.

trol groups; and it gave nine classes for white students and six classes for Negro students to make up the fifteen classes of the full-time experimental group.

A few descriptive remarks about the participating high schools may be of interest. Except in the larger cities, most of the high schools have four grades. The schools usually have a guidance counselor, but there are no set prerequisites for physics. Physics is generally an elective course, and is usually recognized as a college preparatory subject with problem-solving emphasis. Laboratory facilities are available in the larger schools but many of the smaller high schools have poor or no laboratory facilities for physics. Most students entering the course are seniors and have had previous science, algebra and geometry. Nearly all the schools have organized science as a department. Few have used standardized examinations in physics prior to this project.

CHARACTERISTICS OF PUPILS

Approximately 1,200 pupils took the Iowa Physics Aptitude Test and were counted in the experimental or control classes. Approximately 315 pupils viewed the telecasts either completely or more than half the year. Final computations were based upon 186 full-time experimental students for whom data were complete. It was not necessary to use more than a comparable number of matched students and classes from the 511 pupils in the control group for the statistical analysis so computations were based on 236 representative control students.

A few general characteristics of the participating students is of interest. Final achievement test data were obtained concerning 649 white students and 160 Negro students. Ninety-six per cent were seniors. Eighty-nine per cent were boys. Seventy-three per cent were urban, despite the sizable number of rural schools. Characteristically, the physics students were college bound, although in a few classes they were not. The majority (56%) of the physics students were taking five major subjects in their senior year including physics and were active in extra-class affairs. The average intelligence quotient of all the physics students was 113 showing that they were a select or screened group of students.

Standing on Physics Aptitude Test. The median percentile in the Iowa Physics Aptitude Test for all the white students was 62nd percentile (the norm for all students being the 50th percentile). The median percentile in physics aptitude for all the Negro students was 16th percentile.

Table III gives a comparison of the urban-rural groups, the white-Negro groups, and the scores on the physics aptitude test. Often there are no significant differences in aptitude among the groups that would prevent a direct interpretation of achievement test results. However, significant differences in the mean aptitude scores of whites over Negroes, viewing heterogeneous over homogeneous, etc., must be used to interpret correctly some of the achievement test observations.

The research has refined these interpretations in Table IX, by comparing each individual student's achievement with his expected or predicted achievement based on original aptitude and mental ability. It is interesting to note that the Iowa Physics Aptitude Test was a more reliable predictor of achievement than the mental ability test among the white students (significant difference between r .73 and r .59 at the 1% level). This finding was not true of the Negro students for whom the tests were equally predictive (r .58 and r .59).

Student Attitudes. A semantic differential test, as described in Chapter III, was applied to measure student attitudes toward the experience of learning physics from television on the part of the 186 students who had viewed all the telecasts and for whom test data were obtained. The student responses (classed as good or poor) were sorted by conditions of the study and the chi-square test applied to find any significant differences. It was found that:

1. White students gave more favorable responses, and Negro students gave more unfavorable responses (significant difference at 5% level of confidence).

TABLE III. Means and Standard Deviations of Iowa Physics Aptitude Test Scores of Viewing and Control Groups by Certain Varying Conditions

A. By Negro and White Students

	Negro			White		
	N	Mean	S.D.	N	Mean	S.D.
Viewing	69	19.83	8.94	117	41.57	12.98
Control	91	20.19	9.27	145	45.15	11.86

Between means of viewing and control: F 3.75 (1 and 414 df) < .05p
Between means of Negro and white: F 485.62 (1 and 414 df) > .01p **
Interaction between methods and races means: F 3.62 (1 and 414 df) < .05p
Between means of viewing Negro and white: t 13.49 > .01p **
Between means of control Negro and white: t 18.04 > .01p**

B. By Rural and City Students

	Rural			City		
	N	Mean	S.D.	N	Mean	S.D.
Viewing	62	37.52	13.97	124	31.50	18.14
Control	90	39.12	17.64	146	33.31	15.07

Between means of viewing and control: F 3.75 (1 and 414 df) < .05p
Between means of rural and city: F 30.82 (1 and 414 df) > .01p **
Interaction between methods and locations means: F .98 (1 and 414 df) < .05p
Between means of viewing rural and city: t 2.49 > .05p *
Between means of control rural and city: t 2.59 > .05p *

C. By Homogeneous and Heterogeneous Students

	Homogeneous			Heterogeneous		
	N	Mean	S.D.	N	Mean	S.D.
Viewing	96	29.32	15.68	90	37.97	14.41
Control	96	27.66	15.46	140	40.92	14.66

Between means of viewing and control: F 1.86 (1 and 418 df) < .05p
Between means of homogeneous and heterogeneous: F 58.35 (1 and 418 df) > .01p **
Interaction between methods and grouping means: F .82 (1 and 418 df) < .05p
Between means of viewing homogeneous and heterogeneous: t 3.92 > .01p **
Between means of control homogeneous and heterogeneous: t 6.61 > .01p **

D. By Homogeneous and Heterogeneous, Negro and White Students

	HOMOGENEOUS						HETEROGENEOUS					
	Negro			White			Negro			White		
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Viewing	48	16.85	7.39	48	41.79	11.22	21	26.62	8.43	69	41.42	14.07
Control	58	17.74	8.81	38	42.79	10.29	33	24.48	8.46	107	45.99	12.26

Between means of white viewing and control: F 5.38 (1 and 258 df) > .01p **
Between means of Negro viewing and control: F .07 (1 and 156 df) < .05p
Between means of white homogeneous and heterogeneous: F 1.45 (1 and 258 df) < .05p
Between means of Negro homogeneous and heterogeneous: F 32.33 (1 and 156 df) > .01p **
Interaction between white methods and grouping means: F .44 (1 and 258 df) < .05p
Interaction between Negro methods and grouping means: F 1.05 (1 and 156 df) < .05p
Between viewing Negro homogeneous and heterogeneous: t 4.59 > .01p **
Between viewing white homogeneous and heterogeneous: t .16 < .05p

E. By Negro and White, Rural and City Students

	NEGRO						WHITE					
	Rural			City			Rural			City		
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Viewing	11	19.55	6.48	58	19.88	9.28	51	41.39	11.94	66	41.71	13.72
Control	22	13.05	4.58	69	22.46	9.23	68	47.56	10.67	77	43.03	12.44

Interaction between methods, races, and locations means: F 7.54 (1 and 414 df) > .01p **
Between viewing rural and city Negro students: t .14 < .05p
Between control rural and city Negro students: t 6.36 > .01p **

2. Homogeneous classes gave a strongly favorable response, and heterogeneous classes gave a slightly negative response (significant difference at 1% level).
3. White-homogeneous classes gave a more favorable reponse than white-heterogeneous classes (significant difference at 1% level).
4. Both Negro-homogeneous classes and Negro-heterogeneous classes were significantly on the "poor attitude" side of the scale (significant difference at 1% level).

Thus it appears that Negro classes, being low in aptitude at the start, had a feeling of more or less frustration and poor attitude toward the telecasts even though (as shown above) they succeeded equally or better in proportion to their ability. Probably the telecast lessons were difficult for them and they felt that they could not satisfactorily keep up. The favorable attitude toward telecasts shown by homogeneous classes was attributable to the white student homogeneous classes.

Chance of Bias. In the nature of the experiment, a random choice of classes and pupils was impossible. Participation on the part of school districts, and to some extent of teachers, was voluntary. The question is whether such volunteer choice of the experimental classes introduced any serious bias or secular trend.

As explained in a later chapter, a few classes began viewing the telecasts and then interrupted or discontinued viewing, but analysis of causes shows the reasons in most instances to be mechanical, such as poor TV signal, schedule conflicts, etc. A very few classes stopped viewing because of teaching or learning difficulties (three or four classes).

The question is whether the experimental classes were representative. They represented nearly all the physics classes occurring at the designated telecast hour which had television sets available. They compared with the control classes at other hours in student ability and school organization. The most difficult factor to guard against in drawing inferences from the data is that the project itself occurred in a period of transition in the use of education television generally.

RESEARCH RESULTS — PRIMARY ISSUES

With the several groups of pupil-measurement arranged according to the variables of the experiment, analysis of variance[2] was applied and significant differences among the means were noted with the F - test, and significant differences between means with the t - test.

TABLE IV. Means and Standard Deviations of Dunning Physics Test Scores of Viewing and Control, Homogeneous and Heterogeneous Physics Students

	HOMOGENEOUS			HETEROGENEOUS		
	N	Mean	S.D.	N	Mean	S.D.
Viewing	96	30.20	10.87	90	32.89	11.80
Control	96	26.83	12.18	140	37.36	11.23

Between means of viewing and control: F 1.94 (1 and 418 df) $< .05p$
Between means of homogeneous and heterogeneous: F 39.45 (1 and 418 df) $> .01p$ **
Interaction between methods and grouping means: F 10.33 (1 and 418 df) $> .01p$ **
Between means of viewing homogeneous and viewing heterogeneous: t 1.61 $< .05p$
Between means of control homogeneous and control heterogeneous: t 6.73 $> .01p$ **

2. The purpose of tests of significance is to determine the probability (p) that the observed difference is not due to chance. The analysis of variance used was a random replications design with three factors. The F-tests were determined by using the within-cells sum of squares as the error term.

D.E.S.

QUESTION I: Do students in television-taught homogeneous classes have better achievement than in television-taught heterogeneous classes?

FINDING:

1. Among television-taught groups the homogeneously grouped students achieved equally as well as heterogeneously grouped students (Table IV).

2. Table III-C shows that the television-taught heterogeneous students had higher original aptitude than television-taught homogeneous students (significant difference at 1% level of confidence).

3. Since the television-taught heterogeneous students had significantly higher aptitude (Table III-C) than the television-taught homogeneous students, it is evident that students in the homogeneous classes made greater gain than those in heterogeneous classes under television teaching of physics in this project.

4. The difference in achievement of control heterogeneous over control homogeneous is explained as normally expected due to the observed difference in aptitude in Table III-C (significant difference in aptitude was above 1% level).

TABLE V. Means and Standard Deviations of Dunning Physics Test Scores of Viewing and Control, Rural and City Physics Students

	RURAL			CITY		
	N	Mean	S.D.	N	Mean	S.D.
Viewing	62	32.27	12.14	124	31.11	11.00
Control	90	34.06	14.66	146	32.47	11.33

Between means of viewing and control: F 2.56 (1 and 414 df) $< .05p$
Between means of rural and city: F 2.11 (1 and 414 df) $< .05p$
Interaction between methods and location means: F .67 (1 and 414 df) $< .05p$
Between means of viewing rural and viewing city: t .63 $< .05p$
Between means of control rural and control city: t .49 $< .05p$

QUESTION II: How do both television-taught heterogeneous classes and television-taught homogeneous classes compare in achievement with traditionally-taught heterogeneous and homogeneous classes?

FINDING:

1. When experimental and control groups are combined, the heterogeneous students appear to achieve significantly higher than homogeneous students (significant difference at 1% level of confidence).

2. Among television-taught groups the homogeneous students achieved as well as heterogeneous students (Table IV) even though the heterogeneous students had the advantage of higher original ability (Table III-C shows higher aptitude at 1% significance level).

3. The significant difference between combined-group achievement of heterogeneous over homogeneous classes, therefore, is mainly attributed to the higher achievement of heterogeneous classes in the control groups (significant difference at 1% level).

TABLE VI. Means and Standard Deviations of Dunning Physics Test Scores of Viewing and Control, Negro and White Physics Students

	NEGRO			WHITE		
	N	Mean	S.D.	N	Mean	S.D.
Viewing	69	26.42	10.28	117	34.50	10.97
Control	91	26.77	11.86	145	37.03	11.60

Between means of viewing and control: F 2.56 (1 and 414 df) $< .05p$
Between means of Negro and white: F 84.61 (1 and 414 df) $> .01p$ **
Interaction between methods and races means: F 1.62 (1 and 414 df) $< .05p$
Between means of viewing Negro and white: t 5.05 $>$ .01p **
Between means of control Negro and white: t 6.52 $>$ .01p **

QUESTION III: How do urban and rural classes compare in achievement when television-taught or traditionally-taught?

FINDING:

1. When experimental and control groups are combined, the rural students of the study achieved as well as the urban students (Table V shows no significant difference at 5% level of confidence).

2. When experimental and control groups are combined, the rural students in the study had significantly higher aptitude than the urban students (Table III-B shows significance at 1% level).

3. Among television-taught classes, the urban students in the study achieved better than aptitude would predict; but rural students did not achieve as well as their aptitude would predict, although they achieved slightly better than urban students. (Figure 1.)

4. Among control classes, the rural students of the study exceeded significantly the urban students (significant difference at 5% level) in aptitude; but did not exceed significantly in achievement.

5. The gain of rural students in control classes was not significantly different from gain of rural students in television-taught classes (Table IX).

TABLE VII. Distribution, Means, and Standard Deviations of Dunning Physics Test Scores of Viewing and Control, Negro and White, Rural and City Physics Students

	NEGRO						WHITE					
	Rural			City			Rural			City		
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Viewing	11	18.45	4.66	58	27.92	10.56	51	35.25	11.16	66	33.91	10.79
Control	22	15.00	3.58	69	30.52	11.10	68	40.22	11.16	77	34.22	11.24

Interaction between methods, races and locations means: F 7.84 (1 and 414 df) $>$ .01p **
Between viewing city Negro and viewing rural Negro: t 4.85 $>$ .01p **

QUESTION IV: How do classes for white students and classes for Negro students compare in achievement and does ability grouping affect the result?

FINDING:

1. The Negro classes were significantly lower than white classes in aptitude (Table III-A shows significance at the 1% level of confidence). This was true of both experimental and control groups.

2. The Negro classes were significantly lower than white classes in achievement (Table VI shows significance at the 1% level). This was true of both experimental and control groups.

3. When divided into homogeneous and heterogeneous or rural and urban the findings of (1) and (2) above were consistent.

4. Among television-taught Negro groups, the city Negro students achieved significantly more than rural Negro students even though their aptitude means were alike (Table VII shows significance at the 1% level).

5. Among control Negro groups, the urban Negro students exceeded the rural Negro students in both aptitude and achievement.

6. In terms of predicted achievement based on ability and aptitude tests, the television-taught Negro students had more gain than white students (Table IX shows significance at the 1% level).

7. Among television-taught Negro groups, the students in homogeneous classes had higher achievement in relation to their ability than students in heterogeneous classes (significant at the 1% level). Comparison of Tables III-D and VIII indicates that most of the greater gain of homogeneous television-taught students was found in the gain of Negro homogeneous classes.

TABLE VIII. Means and Standard Deviations of Dunning Physics Test Scores of Viewing and Control Homogeneous and Heterogeneous, Negro and White Physics Students

	HOMOGENEOUS						HETEROGENEOUS					
	Negro			White			Negro			White		
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Viewing	48	25.54	10.94	48	34.85	8.55	21	28.43	8.24	69	34.25	12.37
Control	58	21.93	8.81	38	34.32	12.80	33	35.27	11.76	107	38.00	10.98

Between means of white viewing and control: F 3.24 (1 and 258 df) $<$ .05p
Between means of Negro viewing and control: F .05 (1 and 156 df) $<$ .05p
Between means of white homogeneous and heterogeneous: F 1.64 (1 and 258 df) $<$ .05p
Between means of Negro homogeneous and heterogeneous: F 28.12 (1 and 156 df) $>$ .01p **
Interaction between white methods and grouping means: F 1.40 (1 and 258 df) $<$ .05p
Interaction between Negro methods and grouping means: F 9.40 (1 and 156 df) $>$ .01p **
Between viewing Negro homogeneous and heterogeneous: t 1.21 $<$ .05p
Between viewing white homogeneous and heterogeneous: t .31 $<$ .05p
Between homogeneous Negro viewing and control: t 2.02 $>$ .05p *
Between homogeneous white viewing and control: t .22 $<$ .05 p
Between heterogeneous Negro viewing and control: t 6.73 $>$ .01p **
Between heterogeneous white viewing and control: t 2.86 $>$ .01p **

TABLE IX. Comparison of Student Gain (Achievement over Predicted Achievement) According to Several Critical Factors

Condition	A. Television-Taught Student Mean Variation from Predicted Achievement	B. Control Student Mean Variation from Predicted Achievement	Probability t-test by matched pairs
All students	.65	- .78	A x B: t .56 < .05p
1. Rural students	-1.52	- .45	A1 x B1: t .46 < .05p A1 x A2: t .50 < .05p
2. Urban students	1.73	- .87	A2 x B2: t 1.42 < .05p
1. Negro students	3.99	4.64	A1 x B1: t .09 < .05p A1 x A2: t 5.01 > .01p**
2. White students	-1.33	-2.01	A2 x B2: t .34 < .05p B1 x B2: t 7.21 > .01p**
1. Homogeneous class students	1.72	-1.17	A1 x B1: t 1.23 < .05p A1 x A2: t 3.08 > .01p**
2. Heterogeneous class students	- .50	- .71	A2 x B2: t 2.47 > .05p*
1. High ability students	- .63	-1.36	A1 x B1: t .96 < .05p
2. Low ability students	2.73	.80	A1 x A2: t 1.17 < .05p
3. Average ability students	- .04	- .95	A2 x B2: t 1.06 < .05p A3 x B3: t .00 < .05p
1. High expenditure districts	-1.27	-2.32	A1 x B1: t .65 < .05p A1 x A2: t .64 < .05p
2. Low expenditure districts	-2.87	.50	A2 x B2: t .65 < .05p
1. Good teacher attitude	2.34		A1 x A2: t 3.69 > .01p**
2. Poor teacher attitude	-6.96		
1. Good pupil attitude	- .63		A1 x A2: t .001 < .05p
2. Poor pupil attitude	-1.47		
1. Good laboratory facilities	.34	- .95	A1 x B1: t 1.14 < .05p A1 x A2: t .25 < .05p
2. Poor laboratory facilities	.73	- .18	A2 x B2: t .22 < .05p
1. Large size classes	1.12	-1.53	A1 x B1: t .95 < .05p A1 x A2: t .23 < .05p
2. Small size classes	.21	1.27	A2 x B2: t 1.83 < .05p
1. Good school conditions	-3.35	- .55	A1 x B1: t 2.41 > .05p* A1 x A2: t .65 < .05p
2. Poor school conditions	-1.63	-2.33	A2 x B2: t 1.23 < .05p
1. Stronger teacher training	1.57	-2.58	A1 x B1: t 1.58 < .05p A1 x A2: t .33 < .05p
2. Weaker teacher training	- .72	- .84	A2 x B2: t 1.21 < .05p
1. Strong prerequisites	1.21	-1.59	A1 x B1: t .90 < .05p A1 x A2: t 1.93 < .05p
2. Weak prerequisites	-2.34	-1.03	A2 x B2: t .07 < .05p
1. Boys	.83	- .67	A1 x B1: t 1.50 < .05p A1 x A2: t 2.47 > .05p*
2. Girls	.05	-1.17	A2 x B2: t .17 < .05p
1. Students with 5 subjects	- .90	.41	A1 x B1: t 1.69 < .05p A1 x A2: t .81 < .05p
2. Students with 4 subjects	2.76	-2.50	A2 x B2: t .49 < .05p

NOTE:

* significant at 5% level of confidence
** significant at 1% level of confidence

RESEARCH RESULTS — RELATED ISSUES

A more refined criterion was applied which would equalize for at least the original ability of the students. This was the criterion of "gain" or achievement in relation to ability. The Dunning Physics Achievement Test service (World Book Co.) supplies a chart of expected physics achievement scores for each intelligence score level—at least it gives the achievement score above and below which 50% of the students may be expected normally to occur at any ability level. A similar expectancy or prediction scale was developed by the research staff for Iowa Physics Aptitude Test scores, based on the approximately 1,200 cases available.[3]

To allow for the intrinsic values of each kind of predictive test (the Otis Mental Ability Test and the Iowa Physics Aptitude Test) the predicted physics achievement score for each individual student by both tests was averaged.

3. Iowa Physics Aptitude Test and Dunning Physics Achievement Test raw scores were converted to z-values. Each aptitude test raw score was considered predictive of the achievement test raw score having the most similar z-value.

W.J.P.

Special Definitions:

High ability student was a student with I.Q. 120 or above on the Otis Gamma Mental Ability Test; low ability student was a student with I. Q. 99 or below.

High expenditure district was a district in which average current expenditure per pupil in average daily attendance was $343 or more; low expenditure district was a district with $294 or less average current expenditure per pupil.

Good teacher attitude represented a composite score of 4 or more on a 5-point rating scale; poor teacher attitude represented a score of 2.99 or less. (Method described in Chapter III.)

Good pupil attitude represented a composite score of 3 or more on a 5-point rating scale; poor pupil attitude represented a score of 2.99 or less. (Chapter III.)

Good and poor laboratory facilities were as described by teachers in a questionnaire.

Large size class was 16 students or more; small size class was 15 students or less.

Good and poor school conditions was an arbitrary classification based upon the ranking of districts according to a composite of the following factors: assessed valuation per ADA, expenditure per ADA, physics teacher's salary, educational level of parents, size above 700 ADA, staffing above 50 per 1,000 ADA, laboratory facilities.

Stronger and weaker teacher training was an arbitrary classification based upon a composite score of the following weighted factors: semester hours of college physics (X3), semester hours of other college science (X2), semester hours of college mathematics, years of teaching experience, master's degree.

Strong prerequisites were two required courses in either science or mathematics.

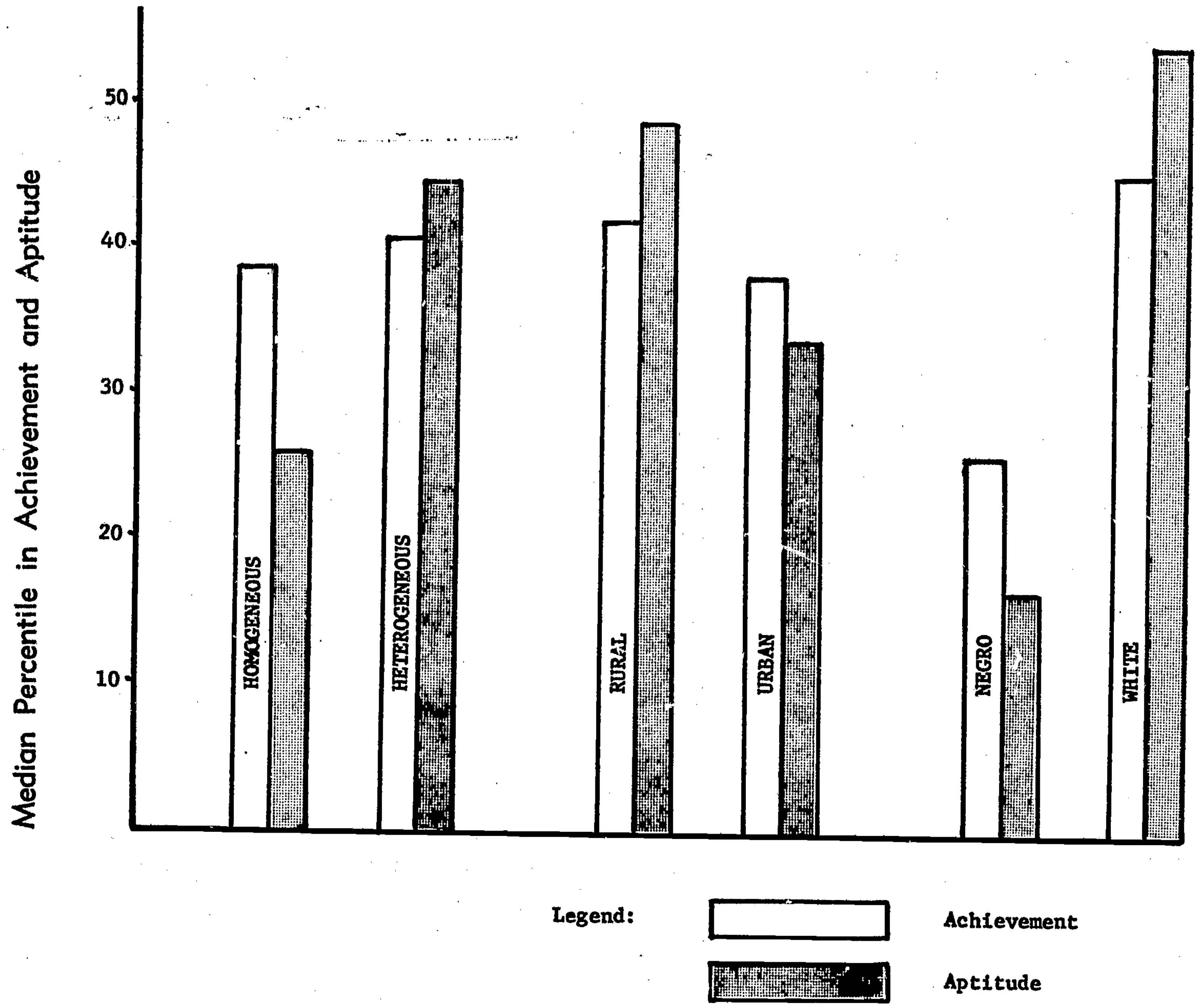

FIGURE 1. Comparison of Physics Test Scores of Television-Taught Students by Characteristic Groups

Thus based on the predictability of both tests there was derived a normal expectancy in physics achievement for each individual student.

Variance or degree of actual over-or-under achievement from such individual student standard was made the criterion of Table IX.[4]

QUESTION V: Is there a significant difference in the student gain with television teaching as between homogeneous classes and heterogeneous classes, city and rural classes, white and Negro classes? (Refer to Table IX.)

FINDING:

1. When achievement in physics is compared with predicted achievement, based on mental ability and physics aptitude tests given at the beginning of the course, the individual students in television-taught homogeneous classes made significantly greater gain than in television-taught heterogeneous classes (significance at the 1% level of confidence).

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4. The significance of the mean gains was determined by computing the distribution of gains (d) between the two correlated series and then determining the significance of the mean of this distribution of d's. The standard error of the difference between mean gains in correlated series is given by $\frac{\sigma_{\bar{d}s}}{\sqrt{N}}$ in which $\sigma_{\bar{d}s}$ is estimated from the standard deviation of the sample gain scores. The formula $\frac{1}{\sqrt{N}}\left(\sigma^2_{x_1}+\sigma^2_{x_2}+\sigma^2_{y_1}+\sigma^2_{y_2}\right)$ was used for the standard error of the difference between mean gains when the two groups were independent.

D.E.S

2. Negro students made significantly more gain than white students. This was true in both experimental and control groups (significance at the 1% level).

3. No significant difference in gain was observed between rural and urban students.

QUESTION VI: Are any particular student or school characteristics associated with significantly larger gain in achievement in television-taught and traditionally-taught classes? (Refer to Table IX).

FINDING:

1. A favorable teacher attitude toward education television and the project was found to accompany larger gain in student achievement in the experimental group (significance at the 1% level).

2. Student attitude in the study was found to have no significant relationship to amount of gain in achievement. (Refer to Chapter III.)

3. There was slight indication (significance at the 5% level of confidence) that students in schools having good school conditions made more gain in the control classes, and that boys excelled in the physics classes.

4. Concerning other hypotheses, no significant difference in student gain was discovered by matched pairs due to (a) level of school district expenditure, (b) quality of laboratory facilities, (c) class size, (d) quality and amount of teacher training, (e) student prerequisites in science, (f) whether students take five or four subjects, or (g) pupil ability level.

SUMMARY

Twenty-nine independent school districts and fifty-three physics classes in the Houston area participated in a project to test the effectiveness of teaching a basic course in modern high school physics by television. The major statistical findings were these:

1. The television-taught high school classes achieved equally as well as the traditionally-taught control classes. This is a remarkable fact when one considers that it was the first time such a project had been carried on in these schools, that the team teachers had to pioneer their role and techniques, and that the independent school districts volunteered to work together in new patterns for common ends. However, this finding is consistent with prior research over the past seven years. It should be satisfactory evidence for the participants in the Houston area that basic instruction by television is not experimental but an effective application.

2. There was evidence, under the conditions of the study, that homogeneous classes were more effective than heterogeneous classes with television teaching. They made greater gain in achievement in relation to ability under television teaching. Also they had a more positive attitude toward television instruction.

3. The rural high school classes and the Negro high school classes made satisfactory gain (actual achievement compared to predicted achievement) with television teaching. The rural classes on the whole did not gain as much as the city classes, considering their shortages of laboratory equipment and trained teachers; but television-taught rural classes made as much progress as the control rural classes. The television-taught Negro classes made more gain than white classes in terms of original aptitude. It appears on the whole that television teaching was an advantage for academically underprivileged groups.

CHAPTER II

Administration of Open-Circuit Television with Independent School Districts

The establishment of working relationships between University of Houston television station KUHT and the public school systems and programs under supervision of numerous independent school boards was a major task, particularly during the spring and summer prior to the first telecasts. Not only did the school district units differ vastly in size, facilities, and schedules; but there was little precedent to follow as to policy, responsibility, and structure of inter-communication in the field of television instruction. Many relationships were clarified during the course of the project and some lessons were learned for the future.

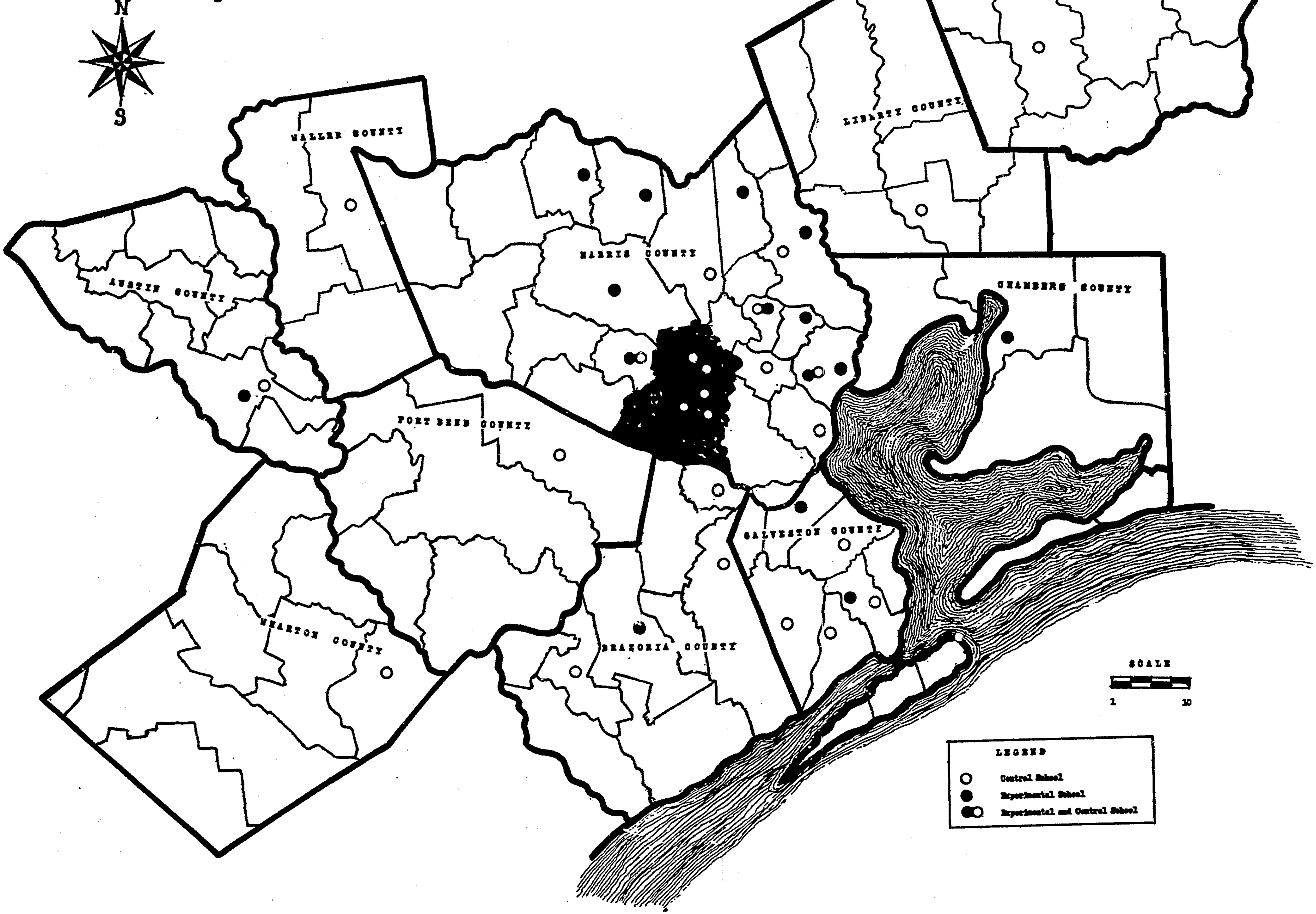
RECOGNITION OF NEED

Probably there were mixed motives back of the request of Harris County public school administrators to initiate a program of telecast lessons in high school physics. Chiefly there was an undefined feeling that having at hand so excellent and experienced a technical facility as University of Houston's station KUHT with its educational telecasts being viewed daily by the community, and in the light of reported success of direct high school instruction by television coming from other parts of the country, it would be expedient for Harris County school systems to investigate the long-range potentials of their own available resource. The University had tested open and closed circuit methods since 1953. It had taught and kept careful records on all kinds of subject content using a wide variety of methods in teaching over 20,000 college course enrollees. In fact, the University had trained its own cameramen, electricians, business managers, directors, and producers. It had handled every type of occasional production. There was ready efficiency available to carry out the proposed project according to its express purpose. Thus the organization of a Houston area project could develop rapidly, and experimental controls from the standpoint of uniform, experienced production were assured.

Immediate needs were more explicitly stated. There was a need to raise curriculum standards if possible, and modernize the teaching of high school physics. A well-qualified television teacher, devoting full time to a three-days-per-week lecture-demonstration series, could serve this purpose. He would have much more time for planning and preparation than the already full-scheduled science teachers have. Studio presented lessons would utilize excellent and expensive equipment for demonstrations by television instruction that school districts generally could not afford to duplicate for all the individual classroom instructors. In fact, some of the high schools in the Houston area either had poorly equipped or no physics laboratories at all. Students also would be motivated by an intensity and magnification of demonstrations not otherwise visible even in the well-equipped classrooms; not to mention the possible studio introduction of guest scientists and television field trips for enrichment. The telecasts would set a new standard in physics teaching; both white and Negro, and both urban and rural schools could view the same excellent lectures, take the same uniform sets of standardized tests, and follow the improved outline of modernized physics content.

Some school districts wished to investigate the effect of homogeneous grouping—the principle of matching class groups to teaching method and teaching method to pupils. Altogether it was believed the television viewing audience

FIGURE 2. Map of Houston Project Area Showing Location of Experimental and Control High Schools.



would be quite large and, while regular physics classrooms would be retained, the school districts involved would get more value for money spent.

CONTRACTUAL RELATIONSHIPS

The original proposal provided that for the twenty independent school districts of Harris County a contract should be made between the local school boards and the television station. Actually no written contracts were executed. The reasons given were: (1) there was not found time between definite notification of a government research grant (July) and the first trial telecast lessons (September) properly to prepare a working arrangement among independent school boards, and (2) a fear that if a written contract were made prerequisite, many school boards might refuse, inasmuch as their classes could view open-circuit telecasts without an agreement or for other local reasons.

Houston Public Schools paved the way toward working relationships by offering to supply a television physics teacher on a full-time basis. The Harris County School Administrators Association committee decided to ask other participants in the county outside of Houston to contribute the sum of $3,795. A questionnaire was sent to all independent school districts (about 73 districts) within maximum viewing range of station KUHT. About thirty-five districts immediately expressed a strong interest in participating either as viewers of the telecast lessons or as control groups. The sum to be contributed by viewing groups was pro-rated to school districts according to their high school enrollments—the cost to districts amounting to 22 cents per high school pupil. The government research project supplied a total of $58,748 and the University of Houston, College of Education, furnished staff and facilities.

The form of contract as described above resulted in eleven independent school districts of Harris County participating actively in the experiment of teaching by television and eight school districts in counties outside of Harris County. Besides these contracting districts a very generous contribution was made by fifteen or twenty other school districts which accommodated the project by administering all the tests and serving as a control in the study but which did not contract to view the telecast lessons nor bear any direct contract cost. (Figure 2.)

Indirectly the project made a substantial contribution to the high school physics curriculum and standards in Houston area schools. All physics teachers and high school administrators who manifested an interest in the Modern Physics lessons by attending the preliminary conferences, volunteering to act as control classes, or writing for information, were carried throughout the year on a mailing list to receive the published lesson guides prepared by the television instructor and his committee. Thus not only the experimental class teachers, but the control class teachers, and some teachers who inquired at the beginning but later dropped out of participation, all received the same regular weekly mailing of lesson outlines and materials. This means of exchange served to assure that control classes had an opportunity to cover the same subject matter as experimental classes; it encouraged the interest of many teachers outside the participating group, indirectly setting new curriculum standards in modern physics for the whole region. Of course, the lesson guides functioned as a direct channel of communication by mail between the television instructor and the team teachers in charge of viewing classes since the television instructor could insert notes and comments from time to time and so keep team teachers informed sufficiently in advance of what to expect in forthcoming telecasts.

A further stipulation of the contractual relationship was that the project budget would supply both experimental and control groups with a testing battery: Iowa Physics Aptitude Examination, Form M; Otis Gamma Quick-Scoring Mental Ability Test; Outterson Mid-term Physics Test[1]; and Dunning Physics Achievement Test. These standardized tests

1. The **Outterson Mid-Term Physics Test** and **Outterson Final Physics Test** are available in sets from Bureau of Education Research and Services, College of Education, University of Houston, Houston 4, Texas.

were scored at the Bureau of Education Research and Services, College of Education. The results, with suitable analyses, were returned without cost to individual schools cooperating in any way in the research project.

Since all these procedural steps combined to stimulate standards in the control as well as the experimental classes they may have affected the research results by reducing observed differences between experimental and control groups; but such an effect was wanted in order to be sure that observed differences (Chapter I) could be accounted for only by the method, i.e. television vs. conventional instruction.

SCHEDULING CLASSES AND TELECASTS

By the time the project officially got under way in July, the high school administrators of the region had already adopted their fall class schedules. This was considered an unfortunate circumstance. Although the possibility of high school physics teaching by television had been generally discussed, no practical adjustments could be enacted until the government grant was assured. Schools could not wait to complete their class schedules on the chance that a research grant would materialize, because customarily many of them announce fall class schedules before school is closed for summer vacation. Many fixed items must be planned around in constructing a high school class schedule such as cafeteria periods, bus schedules, laboratory courses requiring special rooms, teacher assignments, etc. Since high school physics is commonly a senior or a junior class subject, the problem of electives and individual course-conflict avoidance often dictates which period of the day would be advantageous to a majority requiring the subject on this grade level.

In a survey conducted during the summer vacation months, a majority of the high school administrators signified their interest in having the television instruction of physics scheduled during a 10:30 a.m. to 11:15 a.m. period. To accommodate this apparent majority of schools, Modern Physics telecast lessons were then announced for the 10:30 a.m. hour on Monday, Wednesday, and Friday of each week, holidays excluded. Other high schools attempted to adjust their classes so as to schedule physics at the 10:30 a.m. hour. Additional difficulty developed in that periods did not start exactly at the same minute, 10:30 a.m., in all of the high schools — bus schedules, homeroom periods, overlapping lunch periods, etc., combined to make local time schedules very non-uniform. The high schools had never before tried to get together with their scheduling in this manner.

Fortunately, at this stage of planning, station KUHT offered to record the telecast lessons on video-tape and repeat the lessons at a second telecast hour from 11:30 a.m. to 12:15 p.m. on the same days. A U. S. Office of Education supplementary grant covering the added cost of telecasting twice daily made it possible to establish both a 10:30 and an 11:30 a.m. schedule. This increased the number of high school classes which could participate in viewing telecast lessons. Eventually 11:30 a.m. proved to be the more popular period for viewing classes. The television station also found it more efficient and economical in the management of their technical production to record telecasts on video-tape rather than to work under pressure of live showings.

Many high school administrators went to some length in making adjustments to the announced hours of telecast. They rearranged physics laboratory sections, moved physics classes to available free periods, allowed pupils to span two periods in order to view the total program, and reorganized blocks of time in the class schedule. On the other hand, several school districts were indifferent and did not provide a television receiving set for their physics classes—the most common reason given for not participating in the project at the beginning of the season. These are questions to resolve in a cooperative enterprise among independent school districts.

It is not exactly clear today how much, if any, the actual number of classes viewing the telecast lessons might have been increased, considering traditional high school scheduling procedures, even if the high school principals had had ample advance notice of the hour of telecast. Possibly the number viewing telecast lessons could have been increased from fifty per cent to one hundred per cent by advance planning, but this is doubtful. Of thirty-nine high schools participating as experimental or control groups, twenty-nine had only one physics class daily and ten had multiple physics classes. Typically, in one-physics-class schools the physics classes were relatively small, averaging twelve pupils each. Of the schools which did not take part, a great many were not offering physics or did so only on alternate years. On the other hand, large high schools having multiple physics classes (nearly all of which were also in the control group) could normally schedule only one of their physics classes at any given telecast hour. If large high schools were to combine classes in order to meet at a given telecast hour, they would have to depart from traditional class scheduling practices entirely. In this experiment it was decided early that no mass-group instruction would be undertaken. Traditional organization of courses of instruction for juniors and seniors would be preserved, and the respective high schools would try to meet a common telecast hour with regular physics classes if it were reasonably possible.

For an introductory project, the fact of having had twenty-two viewing experimental classes in fifteen school districts of the area was considered excellent cooperation.

FULL-TIME AND PART-TIME VIEWING

It has been noted that fifteen physics classes watched all the telecasts and followed completely the outline instructions. There were seven classes which viewed telecast lessons a part of the time or year (approximately half the lessons), and engaged in related work. The reasons or circumstances concerning such part-time viewing were these: Two of the seven classes were on a January promotion schedule so that each could be full-time viewers for only a half-year; one of the classes was retarded in ability and could not keep up to the lesson standards; in two classes the children were inattentive, or the teacher decided they were not getting enough out of the television viewing; and in two classes the pupils watched on the average one or two telecasts a week all year because an irregular weekly class schedule interfered.

Another interesting category was eight physics classes in the area which could have viewed the telecasts but did not do so, or else they dropped out at the end of the first one or two weeks of telecasting. Reasons given in detailed interviews with the physics teachers were these: In five school districts either television receiving sets were not provided as hoped for, or did not work satisfactorily; in one school district the lunch period interfered so that the physics class could watch only a half of each daily telecast; in three of the classes the local teachers experienced early dissatisfaction such as "the children voted not to watch," "children were restless and fell behind in the work," "parents were critical because the telecasts were over the heads of children termed a slow group," or "teacher decided he could do a better job than the television instructor."

On the whole the research project was represented as a cooperative undertaking and school administrators treated the teachers and class participation on a voluntary basis. Obviously, while complete adherence is not expected in such a cooperative or voluntary situation, had there been more time to instruct these non-participants in advance several might have been very favorably inclined toward an active part in the program. The administrators and teachers could have planned jointly. More of the circumstantial type of obstacles certainly could have been overcome.

From a research standpoint, only a few of the available physics classes not actually in the full-time viewing experimental group were excluded because of personal bias—possibly three or four classes. The other excluded classes were due to such physical conditions as inadequate television signal, lack of proper receiving facilities, or various irregular-schedule conflicts.

PROVISION FOR ORGANIZATION

The school administrators cooperated in the project through their designated advisory committees. The high school physics teachers held five planning meetings and ten advisory meetings with the television instructor during the year. The major conferences in September were attended by fifty physics teachers. All the participating school systems concur that starting with the beginning of a summer vacation and having a September deadline for the first physics lesson telecast did not permit enough time for preplanning and adjustment. In so complex an experimental design, the exigencies of administration demand a preparation period of approximately one year. While such meetings as were held during the Houston area project were enthusiastic and achieved specific planning objectives, the participating school systems recommended that it would have been better to have worked out more carefully the scheduling adjustments, to have given the team teachers more technical preparation in advance, and to have established easier two-way communication between the classroom teacher and the television instructor.

Assuming that open-circuit telecasts are to be applied in traditional classrooms under independent local school district leadership, the following provisions for organization ought to be considered:

1. A mutually convenient hour for telecasting lessons should be announced early enough in the season to enable maximum adjustment of high school class schedules.

2. The team teachers should be trained as thoroughly as possible for their assignments.

3. Lesson materials (and lessons) should be developed through cooperative planning, with team teachers financially compensated for their personal expenses in such preplanning work.

4. Improvement should be made in two-way communication between the television instructor and the viewing classes and teachers, if only by daily stated office hours. Every avenue of communication should be explored.

5. Supervision of the team teachers should be arranged to assure adequate services and know-how.

6. Local school administrators and school boards should not expect to get results by a **laissez-faire** approach. They must become dynamic policy-makers and interpreters. Administrative personnel must function actively as channels of communication, as expeditors, as programmers of tests and other evaluations, and as responsible creators of the learning situation.

7. Opportunities should be provided for exchange of professional experiences among team teachers of the several participating school systems. Teachers should be encouraged to be creative in planning lessons.

8. Telecast lessons should not occupy the whole class period but should allow teachers enough time before and after the viewing for necessary team-teacher functions.

9. Study should be made of classroom conditions—space, seating, television viewing, acoustics, freedom from undue distractions, convenience to related activities—before attempting classroom learning by telecast.

CLARIFICATION OF OBJECTIVES

There are two major issues: that of **purpose** and that of **responsibility.** Neither can be settled in this report, but experience with the Houston area project shows it very desirable that some general agreement on each be reached among participating school districts and for each separate district.

Purposes. The school administration, television center, and team teachers will operate more effectively if they decide in advance upon the major or primary purpose of the telecasts. If the television instructor is expected to present basic curriculum instruction he will develop his lessons accordingly. This is partly involved in the question of what percentage of class time should be spent viewing telecasts as discussed in the next chapter.

The television screen is found to have virtues of vividness, magnification, complete perception, and immediacy that help impel learning. The television instructor therefore will use methods that capitalize on the screen, while trying to compensate for some shortcomings in the studio conditions. At the same time, the team teacher will earnestly seek to complement the basic course presented by television.

But on the other hand if the major goal of educational telecasting is enrichment only, a classroom teacher will, having scanned the prospectus of the lesson, very likely determine for himself if the class, or a part of the class, should view any particular telecast. This places the television presentation in about the same teaching category as visual aids.

Both approaches can be justified but probably these purposes are so divergent they cannot be successfully mixed for any extended period of time. Perhaps occasionally they can be mixed. The purpose of the Houston area project having been established as basic instruction (Chapter I), the television instructor could de-emphasize some mass media aspects of visual aids and play up the personalized, individual learning approach. He could work for continuity, realism, best-view, concentration, animation, and flexibility in teacher-pupil relationships.

Other considerations can determine purpose: that of providing many kinds of lessons which a school otherwise could not afford, or substituting telecast lessons for a lack of trained teachers in such subject areas as elementary foreign languages, or saving of teacher salaries by large-group viewing of telecast lessons, or providing of instruction to very small groups where a school system could not supply fully-qualified regular teachers. Nor does this list exhaust the possible special purposes of telecasting lessons. From the standpoint of adequate administration, the educational philosophy should be examined, suitable policies adopted, school personnel involved by a democratic procedure, and then a program of telecasts so established as to achieve as many values as possible within the outline of purpose.

Responsibility. There could be a tendency to launch into telecasting lessons with unanimity of purpose but without having thought through the question of responsibility. How will pupils be assigned to viewing groups? Will they have the background and ability for the work (although some research indicates considerable flexibility to be practicable on this score)? Who will be responsible for daily progress of the individual child, the television center or the team teacher? Will uniform, standardized tests be utilized for final grades; or who assumes ultimate responsibility for giving grades and credits? Who is responsible for classroom viewing conditions, for pupil attitudes and conduct, for home cooperation? Many of these questions may dissolve as experience and technique improve (refer to the next chapter).

One answer to all these questions is that local school administration is responsible. When the question of responsibility is settled, the role which each party to the cooperative enterprise of telecasting lessons shall play becomes much more clear and more efficient.

Need for inservice education. Many of the classroom teachers watching telecasts with their classes expressed an interest in having an opportunity to attend in-service courses which would develop team-teaching techniques and enable them to think through some new and effective practices for this relationship. Many found that they had learned new ways of presentation to a class or of conducting physics demonstrations simply by watching the television lessons. This suggests that while programs of in-service education necessary for the staff efficiency of a school system have often been costly and difficult to arrange, all kinds of in-service education could be conveyed directly by television to many viewers along with the instruction to students. Instead of theorizing about improved classroom methods, the medium of television could be used to demonstrate the application of such methods. Such an approach could be utilized, for example, in a rapid improvement of elementary school science where many elementary teachers experience a need for more training themselves in the newer physical science branches.

For many years inter-class and inter-school visitations have been considered a stimulating means of keeping the faculty alert to effective practices. Summer session classes and school supervisors have sought to spread the knowledge of improved methods among experienced teachers. The process of diffusion (once thought to be a fifty-year process) might be greatly accelerated if telecast lessons were designed to do that very thing—bring new improved practices to the attention of teachers. Probably the television lessons would not constitute a total in-service program for team teachers. In-service seminars would also be needed for a discussion of specific team teacher relationships. Such teacher seminars, however, would become vital and creative if combined with the demonstration-teaching effect of an actual series of television lessons.

COST FACTORS

School districts involved in this project had a median current expenditure of $300 to $350 per pupil per annum. The poorest districts spend at about the state-supported minimum foundation program level or $205 per child per year. The wealthiest spend over $550 per child. This cost must cover all school operational expenses, salaries, transportation, equipment, and overhead other than debt retirement for the total school program as offered the child. In the television project the per unit cost for televising lessons including the salary of instructor, but excluding cost of research and administration, would have been around $200 per student for the full-time experimental group only.

Obviously this computed unit cost of television has to be more in line with that of all school purposes to warrant permanent application beyond the present research stage. Television teaching should economize public school costs, or give added value to the money spent, or be subsidized by other sources, or be reduced to a unit cost in line with what a school district now spends per subject-hour per child. Further subsidizing can be justified because much additional research ought to be given this promising medium. But the realistic and practical problem for independent school districts is to explore the possibility of a reduction in unit costs.[2]

Telecasting warrants. Some controversy exists as to warrants. Judging from experience in the 1959-60 project, to do a similar job of live telecasting physics lessons for an entire school year might entail a unit cost of let us say $10 per viewing high school student for somewhere between 1,000 and 2,000 student viewers. Increasing the number of viewers of telecast lessons reduces unit costs; whereas purpose and type of telecast program determines total cost.

Nevertheless, it was firmly agreed among participants in the project that whatever the kind of program, telecast lessons themselves must be of maximal quality. Usually the television instructor has to be a full-time worker; he has prepare exceptionally well. A studio production must without question be technically superior. Team teachers and students are prone to be most critical of even the tiniest fault. Telecast lessons both in content and in professional skill are expected to exemplify the standards of a master teacher.

Reducing the cost unit. Many suggestions have been offered to make the television unit costs more acceptable within budgetary limits of regular operating school districts: (1) Choose as subjects for basic television instruction those in which a large number of schools and classes can utilize the telecast; at certain grade levels like the intermediate grades more than two thousand children of the Houston area could easily be assigned to watch a prearranged series of telecast lessons. (2) Develop relay stations which would extend the viewing range of the signal. (3) Pioneer new courses such as junior high school science and foreign language which would justify a new viewing audience. (4) Repeat programs on closed-circuit television. (5) Economize with large-group viewing, thus utilizing the school staff more effectively. (6) Produce integrated subject matter for the team teacher, thus giving telecast lessons a more special and limited function with less frequent telecasts. (7) Repeat and exchange telecasts through use of video-tape. (8) Reduce the costs of production. These and other means to achieve cost-value need to be explored.

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2. Cost accounting need not necessarily be for a single subject of instruction but may include an entire schedule of educational programs serving multiple-purposes in the school systems. Successful community-service education television centers such as station KETC in St. Louis, station WQED in Pittsburg, and station WCET in Cincinnati, have for several years provided in their regions a block of time for educational telecasts to the public schools. Within this block of time the public school administrators have, through responsible, representative planning boards, arranged and presented a varied schedule of telecast instruction serving the needs of all levels and types of curriculum and activities in the school systems of the region.

SUMMARY

From such an introductory experience in cooperative administration of open-circuit television instruction among independent school districts as the Houston project has been, several conclusions may be reached:

1. Organization of education television in the public school program is so complex a task that it requires the skills of a professional educator, as well as the competencies of the television producer. Technically trained supervisors of educational television are required who have a broad knowledge of public school teaching, methods, curricula, and administration. Successful education television centers usually have available such persons of unusual competence who direct the television instruction with the public school systems and serve on the supervisory staffs of the public schools as curriculum consultants and coordinators.

2. Basic instruction by television rather than voluntary viewing on the part of classroom teachers appears the most promising development; but this will require that local school administrators assume full responsibility, that a contractual agreement lending stability be reached between school district and the television producer, and that team teachers be involved in the planning. The concept of team teacher as introduced by education television presents challenging opportunities, especially to the better trained and more experienced classroom teachers.

3. Examination should be made of potential economies in education television for school districts and also the matter of unit-cost warrants; but advantages will accrue only if telecast lessons are sustained at maximal quality.

4. In budgeting production costs of education television, a sum must be provided for project administration. The administrative burden of managing complex relationships with the public school districts, the publication and distribution of lesson materials, the constant committee and advisory arrangements, and the essential control procedures, all necessary to effectuate coordinate production with independent school systems, has to be a substantial part of an open-circuit project.

5. While television instruction brings new standards and new resources to the students in the classrooms of the participating communities, perhaps the most important finding of this year's project has been that telecast instruction is one of the most rapid and effective supervisory means to bring improvement of curriculum content and teaching methods in the public schools. It warrants financial support not only as a medium of instruction but as a cooperative device for supervision.

6. A full year of preplanning with independent school districts seems necessary in order to adjust high school class schedules, provide in-service training for team teachers, and cooperatively work out complete integration of telecast lessons with the school curriculum. Experimentation and development, as well as research, is needed in many places. Certain types of content may prove more effective than others for television teaching: demonstration, review, introduction. Communication between independent classes and the television producer is a problem that can be solved with ingenuity.

7. Telecasting of lessons has many administrative advantages such as improvement of the curriculum, establishment of superior standards, encouraging the creative energies of the staff, and bringing to the children features of great value at minimum cost. These available values should encourage additional research and active cooperative planning on the part of administrators.

In many public school subjects the content of courses of study and the textbook material are more or less antiquated. A television-teaching program promises quick results in regard to offering the best quality instructional content. New courses such as junior high school science or elementary foreign language could be established firmly and with less delay were the lessons to be prepared carefully by a specialist with committee assistance, and presented by television. Televised instruction sets a standard in careful and accurate preparation of lectures, demonstrations, and other content. Where there have not been uniform examinations or minimum standards to gauge the progress of the pupils generally, this service also is a natural concomitant of television teaching.

The necessity of cooperation among the independent school districts to sustain central television instruction in 1959-60 in the Houston area project has involved curriculum, standards, methods and quality on a regional basis; it has used the resources of the University of Houston, the leadership personnel of the physics teachers, and the committee participation of all the school systems to accomplish the purpose. Reciprocal gain was demonstrated in the joint regional planning by school districts.

CHAPTER III

Role of the Team Teacher and His Classroom Technique

Knowledge of effective classroom practices in relation to education television was gained (a) by cooperative planning with physics teachers before and during the project and (b) by a structured interview conducted by the project research staff with twenty high school physics teachers who had served as team teachers, that is as co-workers with the television instructor.

The interviews were built around seven main questions:

1. How completely has the class viewed the telecasts, and under what conditions as to environment and organization?
2. Which telecast lessons were most valuable from the standpoint of content and children's learning?
3. How did the children react to the telecasts?
4. What has been the team teacher's role in utilizing television for regular classes (this question developed methodology)?
5. What has been the team teacher's experience with certain factors related to telecasts: lesson outlines, homework, laboratory work, textbooks, testing, individual help to pupils, class projects?
6. How can technique of telecasting lessons be improved in relation to public school work?
7. What problems in general must be overcome to make education television more useful in the future?

These structured interviews were conducted at the conclusion of the project in the physics teachers' home schools. The average length of these interviews was 40 minutes. During each interview, the statements of teachers were recorded verbatim. From this part of the investigation several most promising guidelines for future organization and research were obtained.

Supplementary information had been collected previously by questionnaire concerning background factors of the school districts, the school practices, the classes, the curriculum, and the teachers. Besides interview statements of teachers who had gone through an entire year's experience as team teachers, the "attitudes" of children were collected on a data card for each child.

After each interview with a team teacher the research staff representative made a careful evaluation of his field notes and marked the individual teacher's attitude on a five-point scale.

TEACHERS' ATTITUDES

On the whole, the classroom teachers of experimental groups who had viewed all the telecast physics lessons displayed a very wholesome and creative attitude toward both the project and the future potentials of television instruction. Those teachers who had viewed part-time were also interested in general terms but somewhat less favorable in seeing any specific values.

The following scales give numerically the attitude distribution of the teachers in each category:

SCALE

	−2	−1	0	+1	+2
Number of Teachers:	0	1	3	5	5
a. Full-Time Viewing Teachers	Negative		Favorable		Very Favorable

	−2	−1	0	+1	+2
Number of Teachers:	0	2	1	2	1
b. Part-Time Viewing Teachers	Negative		Favorable		Very Favorable

The experimental full-time viewing students were asked to check their opinions on five-point scales also. Four questions were presented to them: (a) Can a subject be successfully taught by television? (b) Have you found watching telecasts of a subject for a whole year to be boring, fairly good, or very interesting? (c) Does telecasting a subject introduce valuable information? (d) How many periods a week would you like to watch telecasting a subject?

The total replies of approximately two hundred physics students were in percentage proportions as follows:

SCALE

	−2	−1	0	+1	+2
Percentage of Students:	8%		83%		9%
a. Can a subject be successfully taught by television?	Seldom		Partially		Completely

	−2	−1	0	+1	+2
Percentage of Students:	20%		59%		21%
b. Have you found watching telecasts of a subject for a whole year—	Becomes Boring		Is Fairly Good		Is Very Interesting

	−2	−1	0	+1	+2
Percentage of Students:	30%		46%		24%
c. Does telecasting a subject introduce valuable information?	Less than Regular Classes		More than Regular Classes		Very High Quality Teaching

	−2	−1	0	+1	+2
Percentage of Students:	20%	32%	38%	2%	8%
d. How many periods a week would you like to watch telecasting a subject?	One Day	Two Days	Three Days	Four Days	Every Day

Clues to reactions of students are found in the occasional comments of team teachers taken from field notes of the teacher interviews:

"Acceptance has been wonderful. Children say they see much on TV telecasting they could not see in an ordinary class."

"Some wanted to quit after mid-term, but now they like it."

"All our students in the class were A or B; all catch on very well."

"At first not too interested because lessons went too fast; then the students got used to it."

"Teacher thinks we will have twice the viewers next year; others in his department would like to try it also."

"The pupil viewer is on his own; he must take complete notes and pay attention."

"Successful in areas where you cannot obtain superior teachers or resource men. One showing saves duplicating costly equipment in all schools."

"Very good television personality. The children liked him."

"Much better to have lecture series for continuity; the resource units would tend to have too much movie atmosphere."

"Is not in competition with the classroom teacher unless television viewing monopolizes too much time."

"Haven't missed a program."

The teacher interviews were directed mainly at constructive ideas for the future. Some clues as to irritations or negative observations are evident in field notes of the interviews:

"Sometimes the pupils could not follow the lecture—too much mathematics."

"Time is too limited in the course, especially to get in the laboratory work."

"Second semester the teacher had to review extensively."

"Television teacher would lose some slow students; but when he would repeat the good students became bored."

"Only criticism is that students could not ask questions on the spot."

"Those unwilling to work hard fell farther behind than non-viewing students."

"Some students liked the telecast lessons but others did not—vote was 13 to 10 to continue."

"Started with high interest, but after the first semester some students became bored or listless. They found they could not participate."

"If you don't prepare for it, you are lost."

"This was a retarded class to begin with. The teacher had to take over."

"Basic thing is to get parents to accept it."

"Also, the teacher needs to be better prepared."

The teachers of experimental full-time viewing classes characterized individual pupils who **gained maximum value** from telecast lessons as "those of most ability, honor students, interested in the field of physics, having had chemistry and mathematics, planning to go away to school, having strong vocational interest or purpose, depending sometimes on whom they associate with, or if all the students are of about the same kind." In contrast, the same classroom teachers described individual pupils who **gained the least value** from telecast lessons as "those who don't see any farther than high school, who get less out of anything else and were taking the course only for credit, not qualified to be in the class, attending only for cultural purposes, interested mostly in sports, disinterested in science or poor in mathematics background, or a few inattentive ones." These literal descriptions taken from field notes of interviews with team teachers of viewing classes appear very similar to what one might expect in the control groups as well (although interviews were not conducted with control group teachers to verify the inference).

EFFECT OF ATTITUDES

In Chapter I it was found that teacher attitude was a factor closely associated with the success of student learning by television. Pupil evaluations did not correlate as strongly with actual learning as might be expected. The research staff observed after systematic investigation that general attitudes by team teachers at the conclusion of the project were of much less consequence than **actual techniques used** by the team teachers. Indeed it was indicated that where the techniques of team teachers had been properly developed and made effective, the attitudes at the conclusion of the project tended to be constructive and wholesome. This conclusion introduces the theme of the balance of Chapter III.

CHARACTERISTICS OF TEACHERS

Of the twenty-two experimental group teachers, fifteen were white and seven Negro. Of the eighteen teachers of control groups, sixteen were white and two Negro. Most of the physics teachers in the project were men (thirty-three men and five women teachers), and most of them were married. As between experimental group teachers and control group teachers, some evident difference existed. The experimental group teachers were typically older, more experienced individuals. Their median age was between 30 and 49 years of age, and their median teaching experience was 9 to 12 years. Only five teachers had less than four years of public school teaching experience, and four teachers had over thirty years of experience.

In comparison, the median age of control group teachers was between 20 and 29 years of age; and all but five had less than four years of teaching experience. In all instances where the telecasts were started and discontinued the physics teachers had had less than eight years of teaching experience. It typically seemed that a seasoned, experienced group of physics teachers had voluntarily chosen to undertake the experiment of team teaching with television and had persevered with it.

Concerning their science and mathematics backgrounds, the median number of college courses in physics taken by individual teachers was generally six courses. Practically all the teachers with only five exceptions had majored either in a branch of science or in mathematics; most of the teachers had majored in chemistry, biology, or mathematics. About twenty-five per cent possessed strong majors or minors in physics. The average of the physics teachers had fifty-one semester hours of science in college and eighteen semester hours of college mathematics. Again team teachers of the experimental classes had the edge with a median of sixty-three semester hours of college science against control class teachers having a median of forty-eight semester hours of college science.

All the teachers in the study hold college degrees; however, ten of the fourteen holding master's degrees were among the team teachers of experimental full-time viewing groups. The experimental group teachers were on the whole more active in professional societies.

LESSON PLANS

The Bureau of Education Research and Services, College of Education, sponsored and published a **Teacher's Guide for the Television Teaching of Modern Physics**[1] containing a prospectus of the telecast content in Modern Physics, and the daily lesson plans provided teachers for each topic of the course outline. A uniform quality and format of lesson plan (Figure 4 displays a typical page) was adhered to throughout the year. Each lesson plan was identified in relation to the course of study by unit and topic; and the projected date of each telecast lesson was announced. The lesson outlines were detailed and definitive, sometimes containing sample problems, explanations, and other aids. A "reading assignment," based upon Texas state adopted high school physics textbooks, was available in advance of each telecast. And a "homework assignment," based upon textbooks used in the schools, was designed to follow each telecast. The homework was explained and motivated during the telecast lesson. Occasionally the outline lesson plans in the "Teacher's Guide" described special resources or activities. Published throughout the school year, the lesson outlines were delivered to physics teachers sufficiently in advance of telecast lessons to enable their personal application in preparing and directing the work of the class.

When the program was inaugurated, all the physics teachers participated mutually, through several called conferences with the television instructor, in the task of deciding upon controlling policies to govern the content and format of the lesson plans. After a few meetings they expressed the view that everything was satisfactorily prepared and working smoothly. They then delegated to advisory committees of teachers the task of continuous month by month surveillance and development of the television lessons. Perhaps, for several reasons, it might have been better to have had all the physics teachers meet regularly throughout the year; but it must be remembered that all these classroom teachers carried a normally heavy load of teaching four or five classes per day, besides their other duties in the local high schools, and that they were given no compensation in time or teaching load for the new experience of entering into the role of team teacher.

Field notes, based on interviews with twenty participating teachers, show that in about 35 per cent of the experimental classes the student interest was sustained at a uniformly good level throughout the year. In 65 per cent of the experimental classes there developed a slump in student interest at about mid-term. But in most instances this seemed to recover as the spring semester progressed. Viewing classes generally ended with good final achievement records, according to the Dunning Physics Achievement Test administered at the conclusion of the telecasts. The quality of telecasts and lesson plans appeared technically uniform during the year; in fact, many of the telecast lessons from which teachers claimed the children gained most (heat, sound, light, and electricity) occurred during the months of January, February, and March. The phenomenon of slump and recovery in student interest may have been due to the fact of this having been an introductory project of television instruction among independent school districts.

As reported by the team teachers, there were during the year certain periods of student adjustment. At first the experience of telecast learning appealed as a novelty, different from entertainment. Soon, with the classroom teacher's control and help, the students acquired special skills of learning in so complex a subject as high school physics. After the Christmas holidays, as the burden of mastering subject content in physics grew heavier, some students did not always prepare adequately in advance, and others needed more special help. Where team teachers continued patiently and attentively to work with the lessons, the students then began to realize gains from the telecasts that they might otherwise not have had; so the final results were encouraging.

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1. Mimeographed publication of approximately 131 pages published for teachers of viewing groups and of control groups, available from Bureau of Education Research and Services, College of Education, University of Houston, Houston 4, Texas.

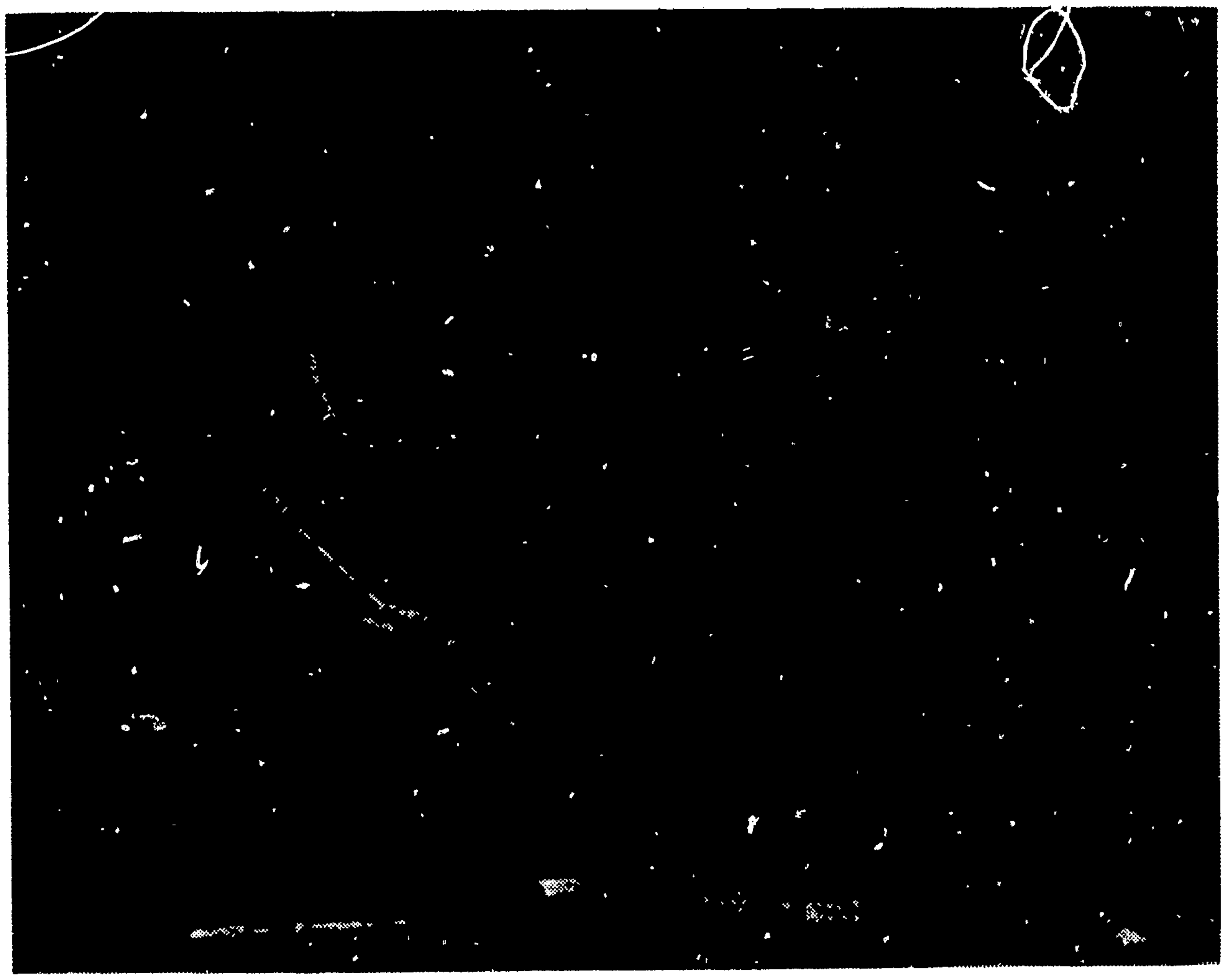

FIGURE 3. Lesson Taught by Television Features Demonstration Method

Perhaps this was the identical way that control classes also had proceeded, although the research staff did not investigate the point. It seems probable that in a second year, when both team teachers and pupils had become practiced in television technique, the psychological patterns might be different and more effective.[2]

It may be that some promising adjustments of the telecast system geared to certain psychological needs of students and teachers deserve attention. A boy said he wished he could press a button and stop the television to ask a question. A teacher observed that after watching each major content unit there could well be allowed a week or so of free time in which to catch up the classroom work. A consensus of the team teachers, having directed the experimental classes, was that fifty per cent of class time ought to be spent in watching television or the shorter telecasts (possibly 35 minutes duration) during three class periods a week but with ample time remaining for questions, discussion, and explanations immediately after each telecast within the class period. Also they suggested the possibility of an interrupted schedule after each major unit which might allow for practical classroom requirements and change the uniformity of pattern. Enough interest in this topic was expressed to warrant at least some study of the relative psychological effectiveness of various ways of scheduling telecast lessons.

2. Refer to program in Hagerstown, Maryland, reported by The Ford Foundation, **Teaching by Television**, 1959; where effectiveness of television instruction appears to gain with successive years' experience in use of the method.

MODERN PHYSICS LESSON OUTLINE

UNIT X: Light
LESSON 58: Monday, March 14, 1960
TITLE: Light As A Wave

READING ASSIGNMENT:

Baker, Brownlee, Fuller: **ELEMENTS OF PHYSICS** pp. 313-318; 395-396

Burns, Verwiebe, and Van Hooft: **PHYSICS A BASIC SCIENCE** pp. 261-262; 327-328

Carleton, Williams, and Buell: **PHYSICS FOR THE NEW AGE** pp. 478-479

Dull, Metcalfe, and Brooks: **MODERN PHYSICS** pp. 394-395; 440-441; 447-448

Marburger and Hoffman: **PHYSICS FOR OUR TIMES** pp. 503-505; 519

LESSON OUTLINE:

The Phase of Waves
1. interference caused by waves out of phase
2. overcoming phase differences - double slit
3. phase of light

Double Slit Interference Patterns of Light
1. Young's experiment
2. the wave length of light
3. visable wave length range of light
4. color and wave lengths

Single Slit Interference
1. effect observed in waves
2. single slit interference in light
3. Huygen's wavelets

Power of Resolution

Interference of Light in Thin Films

HOMEWORK ASSIGNMENT:

Baker, Brownlee, Fuller: **ELEMENTS OF PHYSICS** p. 319, Questions 10, 11, 13; p. 397, Question 3

Burns, Verwiebe, and Van Hooft: **PHYSICS A BASIC SCIENCE** p. 330, Summary Question 13; p. 364, Summary Questions 6, 7

Carleton, Williams, and Buell: **PHYSICS FOR THE NEW AGE**

Dull, Metcalfe, and Brooks: **MODERN PHYSICS** p. 451, Questions 2, 18, 19

Marburger and Hoffman: **PHYSICS FOR OUR TIMES** p. 508, Questions 1, 2, 4

FIGURE 4. Specimen Lesson Plan from the "Teacher's Guide" Publication.

COURSE CONTENT

Figure 5 presents the course of study outline in Modern Physics developed for the project.

The television instructor and chairman of the curriculum committee, John A. Outterson, describes the principles of the course of study as follows:

> The curriculum committee decided that the TV physics course should take an approach which was in keeping with the new medium. The TV course retained the main subject matter topics covered in the traditional course with new additional aspects of these topics included but only as they lent themselves to the unification and clarification of the understanding of the modern physical universe in which we live. Energy, its conservation and transformation, provided the one underlying, general principle which unified the past isolated topics and made the course a logical, integrated whole. In the study of mechanics, energy was introduced and hence became the focal point of the topics which followed in later lessons. For example, we investigated satellites, not from the technological aspects of space travel but rather in terms of the binding energy which held the satellite to the earth. This concept of force fields and the energies associated with them found future applications in the understanding of molecular structure and the effect of heat on substances. In harmonic motion, collisions, and disintegrations we found that our concept of energy offered a basis of understanding and explanation. In electricity we discovered that electric force fields behaved like gravitational force fields; that Coulomb's law explained the electrical nature of a force field while Newton's explained the gravitational. We found that the "work" we had talked about before in terms of force times distance was true in electricity; energy never really changed, only the nature of the force which produces energy transformations, and that our concept of energy was basically true. This concept of energy laid the ground-work for understanding spectra and electromagnetic radiations and eventually explained the nature of procedures used in the investigation of sub-atomic particles and their world. Physics became a finite whole but open-ended, and provided with a logical unifying concept.

PRACTICES OF TEAM TEACHERS

Teachers were asked: "What did the classes do when the telecasts were being viewed?" Generally the rule was to listen, to watch, and to follow the course **down to the bone.** Fourteen teachers instructed the students to take notes.[3] Their impression was that student success was directly proportional to the quality of note-taking. Universally the team teachers in this study permitted no discussion during telecasts. All teachers said they watched all telecasts with the children.

Teachers were asked: "What did the classes do on the 'off periods' when they were not watching the telecasts?" Among statements offered by the teachers were most commonly: (1) laboratory work, (2) testing, (3) problem solving, (4) homework assignment and checking, (5) explanations or discussion. Mentioned less frequently were: (6) either introduce or repeat experiments and demonstrations, (7) give lectures and lesson supplements, (8) review, (9) drill, or (10) allow supervised study.

The research staff observed that team teachers of certain very successful physics classes in the experiment were teachers who had prepared the classes very carefully in advance of each telecast lesson. These particular teachers had developed many ingenious devices—work-study sheets, advance outlines of what to look for, and reading motivation devices. Other team teachers preferred to (or conceived that a team teacher should) only follow the telecasts—that is, act only after prompted by the telecasts. There was a difference of opinion among the team teachers as to which technique is more effective.

In order to get a systematic picture of the practices of team teachers during instructional time when the children are not viewing telecasts, the research staff offered two check-lists to each of the twenty teachers having experimental groups. The teachers were asked to estimate what per cent of instructional time when not watching telecasts was spent on each item in **Check-list A** and to rank in order of effectiveness each item of **Check-lists A** and **B.** The consolidated replies of twenty team teachers appears in Table X.

Responses given in the table were fairly consistent from school to school except for the amount of time spent in laboratory work, since some participating high schools had a very poor or no physics laboratory, whereas others offered excellent science laboratory facilities and as a matter of school policy require an adequate number of laboratory exercises to be completed by each student for course credit. In all the high schools of the study, the physics classes

[3] The development of note-taking guides such as used by the University of Houston's mathematics department would improve the effectiveness of learning by television.

TELECAST LESSONS IN MODERN PHYSICS

UNIT I. **Mechanics of Liquids**
Lesson No.
1. Liquid pressure and force
2. Liquid pressure systems and Pascal's principle
3. Archimedes' principle
4. Specific gravity

UNIT II. **Mechanics of Gases**
5. The atmosphere and weather
6. Compression and expansion of gases
7. Other properties of gases

UNIT III. **Behavior of Molecules**
8. Kinetic theory
9. Forces in solids
10. Hooke's law experiment and forces in liquids

UNIT IV. **Forces**
11. Vectors: adding, resultant force
12. Vectors with trigonometry: vectors in 3D
13. Vectors: resolving
14. Parallel force: torque
15. Equilibrium: center of mass and gravity, stability
16. Friction

UNIT V. **Motion**
17. Velocity: speed, distance
18. Acceleration: uniform
19. Gravity
20. Projectile motion
21. Acceleration: non-uniform
22. Newton's laws of motion
23. Impulse and momentum
24. Circular motion
25. Harmonic motion
26. Steller physics
27. Fluids in motion: Bernoulle's principle

UNIT VI. **Work, Power, and Energy**
28. Work and power
29. Energy: kinetic and potential
30. Collisions and energy transformations

UNIT VII. **Machines**
31. Simple machines
32. TMA - AMA: efficiency of simple machines
33. Compound machines

UNIT VIII. **Heat**
34. Heat and thermometry
35. Thermal expansion: solids
36. Thermal expansion: liquids and gases
37. Specific heat, change of phase
38. Mixture problems
39. Effects of pressure, humidity
40. Transfer of heat
41. Heat and work

UNIT IX. **Sound**
42. Sound and its propagation
43. Other properties of sound
44. Sound and music
45. Musical sounds and instruments
46. Artificial music (special)

UNIT X. **Light**
47. The nature of light
48. Illumination and the perception of light

49-50. Reflection of light

51-52. Refraction of light

53. Lenses
54. Optical instruments
55. The particle theory of light
56. Waves and their behavior
57. Diffraction and the interference of waves
58. Light as a wave
59. Color and polarization

UNIT XI. **Electricity and Magnetism**
60. Static electricity
61. Conductivity and currents
62. Coulomb's law
63. Uniform electric force fields
64. Motion of charged particles in a uniform electric force field
65. Electrical current

66-67. Electric circuits

68. Wheatstone Bridge; electrical energy and power
69. Electricity and chemistry
70. Magnetism
71. Magnetic properties associated with electricity

72-73. Alternating current

74. Generators, motors, and transformers
75. Applied electricity

UNIT XII. **Atomic Physics**
76. Foundations of nuclear physics
77. Atomic structure and spectra
78. X-Rays and nature of radiation
79. Natural radioactivity and radioactive series
80. Sub-atomic world
81. Fusion and fission
82. What does a physicist do

FIGURE 5. Content Outline of Modern Physics Course of Study

are held for five periods of approximately 50 minutes each per week, and do not have extra scheduled laboratory periods. Thus the telecast lessons in physics brought to some high schools their only hope of seeing a good demonstration series; while for other schools it encroached upon available class time for traditionally required laboratory exercises.

The research staff observed that much justification of field trial exists in respect to the relative effectiveness of time allotments and of team teacher methods. Especially needed is an extended period of exploratory search for promising deviates from usual practice in team-teaching methods and a fertile imagination in developing innovations through intermittent telecasts. Once these very promising practices are identified and developed into instruction sheets, they should be field tested under various practical conditions and their effectiveness statistically proven by replications.

TABLE X. Instructional Methods of Team Teachers Working with Television (From interviews with twenty team teachers.)

Distribution of Instructional Time When Not Watching Telecasts	CHECK-LIST A	Rank in Order of Effectiveness (Teacher Judgment)
25%	Solve Mathematical Problems	1st
14%	Comment and Review TV Programs	2nd
14%	Answer Questions Raised by TV	3rd
25%	Use Non-Viewing Time for Laboratory	4th
4%	Assign Daily Homework	5th
7%	Teach New Material Not Shown on TV	6th
6%	Question and Test Learning on TV	7th
4%	Repeat Demonstrations Used on TV	8th
1%	Check Pupil Notebooks	9th
	CHECK-LIST B	**Response**
	Pupils Take Notes During Telecasts	65% Yes
	Informal Seating for Viewing	60% Yes
	Discussion During TV Viewing	Seldom
	Have Only Superior Pupils View TV	Seldom
	Re-Group Classes for TV Viewing	Seldom
	Teach Small Groups While Rest View TV	Seldom
	View Only Part of Period for Enrichment	None
	Have Only Slow Pupils View TV	None
	Use Pupil Monitors	None

PRACTICAL CONSIDERATIONS

Teachers were asked: "What was your experience concerning the following factors in relation to the telecasts?"

(a) **Lesson Outlines** (supplied by television instructor). All teachers used the lesson outline more or less as their personal guide, or syllabus, or course of study. Some based their class plans upon it. Some posted it on the bulletin board. A few duplicated it or invented their own original workbook materials for the students based upon it. This suggests that the teacher's lesson materials which accompany telecasts could be developed in more detail for student use.

Materials in miniature could be prepared; if a chart is to be filled out on the television screen the students could have the same chart in notebook size to fill out along with the television instructor, providing them an experience of active participation as is illustrated in the guidebook prepared by educational and content specialists for telecast lessons in Biology in Cincinnati Public Schools.

(b) **Homework.** Nearly all teachers enforced the lesson outline and the telecast homework assignments, or added to them; a few teachers disregarded them. Again there was a difference in that a few teachers gave the assignments ahead of the telecasts; while many classes lagged behind, with a few children lagging two or three weeks behind. As a rule the uniform assignment system was carefully observed and it was reported to have worked well all the way through the experiment.

(c) **Laboratory Work.** Three teachers had no laboratory; nine teachers held laboratory sections once every two or three weeks, with few facilities and poor equipment; seven teachers, having adequate or excellent physics laboratories, kept up a regular weekly schedule and enforced required laboratory exercises. The latter teachers expressed a desire for more time leeway; particularly they would like some laboratory time in addition to the regular five class meetings a week.

(d) **Textbook and Course of Study.** All teachers stated that a good textbook is an essential counterpart to telecast lessons. This technique they found has worked satisfactorily.

(e) **Testing Program.** Most of the teachers wanted unit content tests every two weeks. One teacher commented that short unit tests would place responsibility on the team teachers.

Evidently a service is desired beyond the mid-term and final achievement tests used in the project.

(f) **Helping Individual Pupils.** Individual student needs, such as weakness in mathematics, were sensed by all the team teachers. Teacher reactions most commonly were to offer help before and after school, and during free periods. The science teachers evidently do quite a bit of this, especially helping individuals with problem-solving. Small classes were remarked by the teachers as good opportunities to help all pupils individually, but the final achievement test results seemed to favor the larger classes. On the one hand the methods of television instruction with coordinate classroom teaching tend to make students assume more responsibility for their own learning, reducing dependence upon teachers, textbooks, and routinized instructions; and on the other hand it opens up vistas for dealing with individual differences through improved use of time and methodology. Rather than mass education, television instruction may tend to individualize education with the teacher finding new opportunities for flexibility of classroom management.

(g) **Class Projects.** Fourteen physics teachers reported having no class projects; four reported having small individual projects for a science fair; two assigned term papers or encouraged voluntary extra projects by the students in the laboratory.

SUMMARY: AREAS NEEDING INVESTIGATION

Teachers were asked the specific question: "Do you think children gain genuine instruction from education television?" Replies of eighteen team teachers were affirmative, and two were negative. All agreed that a team teacher has some unique duties to fulfill and that the particular technique of team teaching is a critical factor in the co-worker's results.

Specific practices such as the following appeared to be associated with exceptional progress on the part of the participating pupils: (1) pupils receiving lesson guides and preparatory discussion, (2) pupils having special instruction in note-taking, (3) review periods just prior to and/or just after watching the telecasts, (4) use of non-viewing time for laboratory work, and (5) special assistance in problem-solving situations. Such promising practices as these need to be incorporated into specific guides or lesson plans for teachers as a basis for further experimentation.

In order for the telecast lesson and the classroom follow-up to be unified, other areas also need investigation. These areas are: (1) advanced training of and preparation by the classroom teacher for his specialized role, (2) a system of daily communication between television and classroom teacher, (3) teaching by classroom teacher new materials not shown on television, (4) eliciting student participation, (5) reinforcement of main concepts presented in telecast, (6) determining which content is most effectively presented in telecast and which in classroom, (7) discovering possibility in differentiated assignments and grouping, and (8) adequate distribution of instructional time between television and classroom teacher.

Further research investigation is recommended to discover and develop new techniques which when utilized by the team teacher in the classroom will increase the efficiency of the team-teaching process. Such an inquiry could be tested by the following hypotheses:

1. That team-teaching techniques significantly deviate from usual practice were observed in the current study which offer exceptional promise.

2. That additional deviate techniques can be devised or discovered through the use of practice television lessons.

3. That these promising techniques can be developed into tangible plans for more refined application.

4. That the validity of these techniques may be tested in experimental telecasts in actual classroom situations.

5. That the variation of team-teaching techniques may significantly affect the learning outcomes in the televised teaching of a given subject.

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